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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

TECHNICAL MEMORANDUM No 70

THE "UNIVERSAL PROPELLER"

BUILT BY PARAGON ENGINEERS, Inc., BALTIMORE, MD.

By David L. Bacon,
Langley Memorial Aeronautical Laboratory.

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The improvements in airplane performance and fuel economy which may be realized by the use of a variable pitch propeller are unquestioned and their more frequent use, particularly on supercharged and multi-engined aircraft, has been delayed principally by the lack of satisfactory designs.

The reversible propeller also has shown decided advantages in decreasing the run of airplanes on landing and in the maneuvering of airships.

The helicopter problem which has for centuries been a fertile field for inventors is now attracting more serious attention than ever before and offers attractive possibilities if the obstacle of very large propellers, variable in pitch and of extremely light weight, can be successfully overcome.

A new design which avoids some of the objectionable features of other reversible propellers is therefore of more than passing interest.

At the request of the National Advisory Committee for Aeronautics the "Universal Propeller" was operated and explained by the inventor, Mr. Spencer Heath, for the purpose of demonstrating the following features of its design.

1. Elimination of continuously running gears, collars or bearings in the pitch control mechanism.

2. The use of engine power in place of manual labor in changing the blade angle.

3. The absence of any structural limitation to the range of blade angles available and the possibility of limiting the blade travel between any two predetermined extreme positions.

4. Continuous indication on the instrument board of the blade position.

5. Automatic throttling of the engine while the propeller is passing through the position of neutral pitch.

Description of Propeller.

The present propeller and operating mechanism represent an experimental development rather than a refined design and as they were built entirely to shop sketches, no scale layout could be obtained and the writer's accompanying sketches are necessarily crude and incomplete.

The two wooden blades are fastened into steel sleeves which in turn are held in a steel hub similar in construction to that used by Hart and others, the centrifugal forces being taken on ball thrusts and torsional and axial forces on plain bearings.

The method of fixing the wooden blades into the steel sleeves is noteworthy. The butt end of each blade is tapered outwardly at a small angle as shown in Fig. 1, and the surrounding collar is split so that it may be first sprung over the butt and then compressed upon the taper.

Pitch Changing Mechanism.

The pitch changing mechanism is operated through the application of a braking force to either one of a pair of small brake drums surrounding the engine crankshaft and normally rotating with it. The elementary principle is shown in Fig. 2, which represents a brake drum connected through a gear train to the individual blades of the propeller. It is apparent that if the drum is allowed to revolve at crankshaft speed, all the gears will be stationary relative to the propeller and that the pitch angle will remain constant. If, on the contrary, the brake drum is held stationary the gear train will be set into action and the pitch angle of the blades will undergo a continuous change until the brake drum is released.

In order to change the blade angle in the inverse direction a second brake drum may be used, connecting to the worm shaft through an idler which serves to reverse the direction of rotation of the worm shaft. It should be noted that during normal flying none of these gears are operative and that the blades are locked in position by the non-reversible features of the worm and the friction of the connected parts.

The actual construction of the pitch changing mechanism used by Mr. Heath is shown in Fig. 3. It will be seen that the mechanism has been somewhat complicated by the necessity of obtaining a large speed reduction ratio between the brake drums and the propeller blades. The brakes are applied through leather faced aluminum shoes operated from the pilot's seat by a light push and pull knob attaching to a brake lever mounted on the drum housing. A small hand crank is provided by which the pitch can be changed while the engine is not running.

Blade Position Indicator.

The angular setting of the propeller blades at any instant is a function of the relative motion which has taken place between the two brake drums. The indicating mechanism is therefore operated by gearing from the two brake drums which conveys differential motion to the indicating pointer and the throttling and pitch limiting cams. As long as the two brake drums revolve both at crankshaft speed the indicating hand remains stationary while if either of them is retarded an angular motion is shown on the indicator equal to that experienced by the blades themselves.

Automatic Throttle Control.

The mechanical throttle is provided with springs in both directions so that the pilot can at any time by applying a force on the throttle greater than the initial tension in the springs substitute manual for automatic control.

Pitch Limiting Mechanism.

In the pitch limiting mechanism the control knob normally connects to the brake levers direct, a push increasing and a pull decreasing the pitch. If the control button is held in either operating position until the limiting position of the propeller blade is reached the cam trips a latch plate and renders the control inoperative in that direction while leaving it ready for use in reversing the direction of propeller blade motion.

Demonstration Under Power.

To show the action under power the propeller and related mechanism were installed on a 150 HP Hispano-Suiza engine mounted with gasoline tank, observers' seats, etc., on a lumber trailer weighing about two tons which was free to roll on the ground between two chocks a few feet apart. The engine and propeller were operated both by Mr. Heath and the writer and put through their entire range of performance, which included disconnecting the pitch limiting mechanism so that the blade angles were controlled throughout a complete revolution of 360 degrees, both forward and reverse.

With the engine turning at about 1000 r.p.m., the angular change from full speed ahead to full speed astern was accomplished in about five seconds.

Conclusions.

The present mechanism, although but a crude embodiment of the inventor's principle, fulfills his claims as listed at the beginning of this report, and might easily be redesigned into a practical flying accessory.

It is obvious that some of its advantages are gained at the expense of additional complication and the question immediately arises whether they are worth it. In the opinion of the writer the novel features of this propeller are of sufficient value to warrant its redesign in a compact and lighter unit for prolonged service tests on either airplanes or airships. Any pitch changing mechanism for use on a helicopter must necessarily be designed as an integral part of the structure, and it remains to be seen whether designers will care to use Mr. Heath's patented ideas or will prefer to undertake the additional and by no means simple task of inventing and perfecting some mechanism of their own.

David L. Bacon,
Assistant Physicist.

Langley Field, Va.

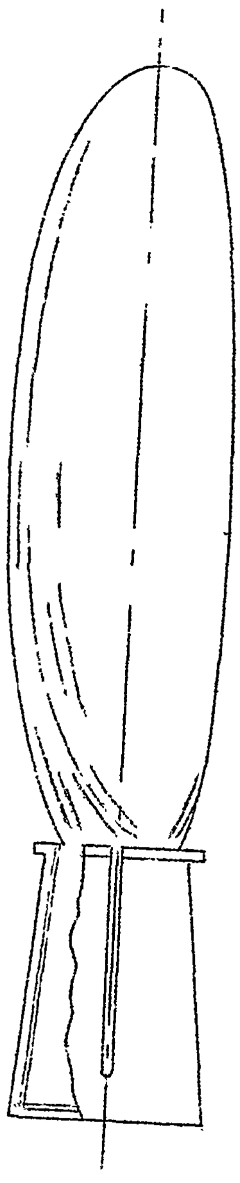

Fig. 1. Split steel sleeve compressed about butt end of propeller blade.

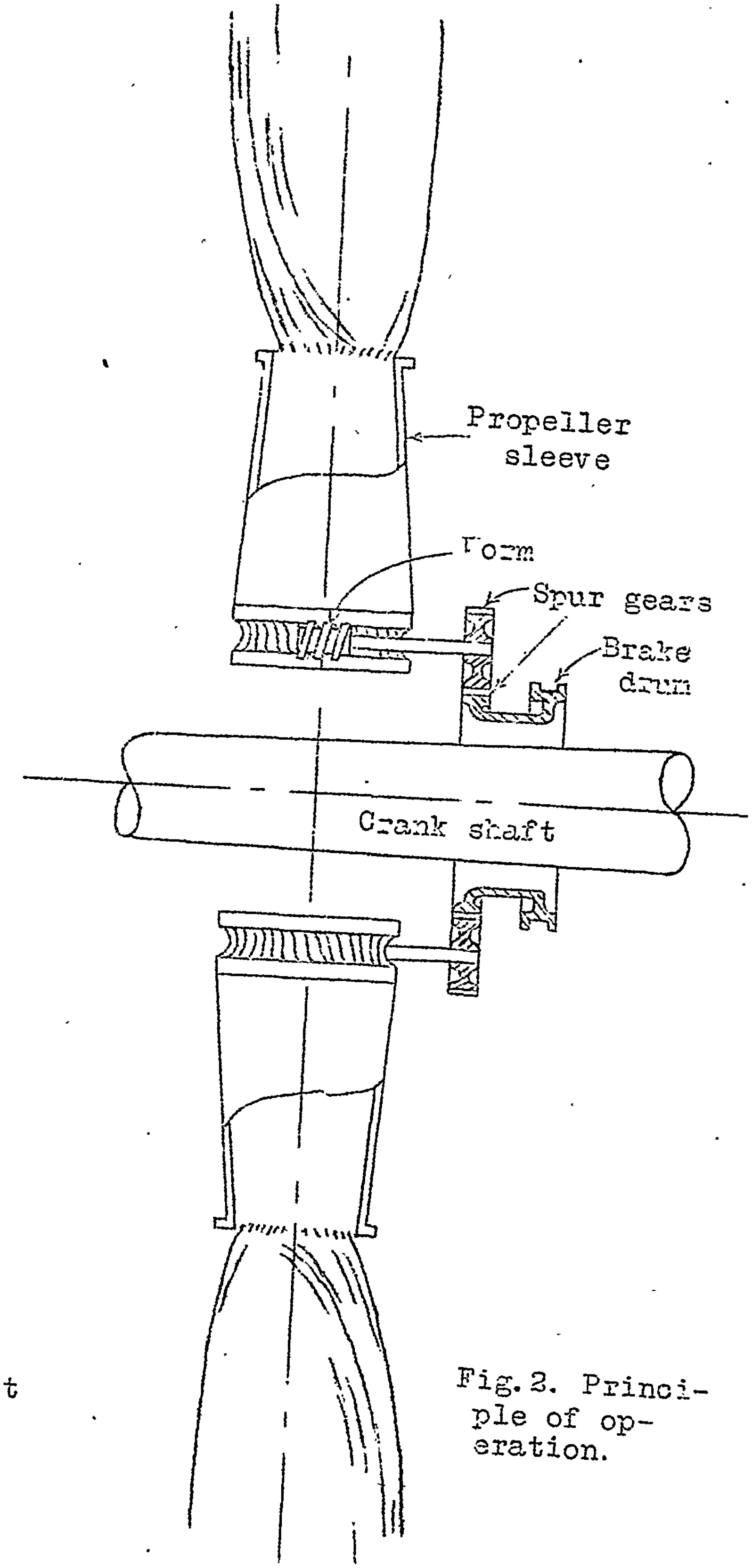

Fig. 2. Principle of operation.

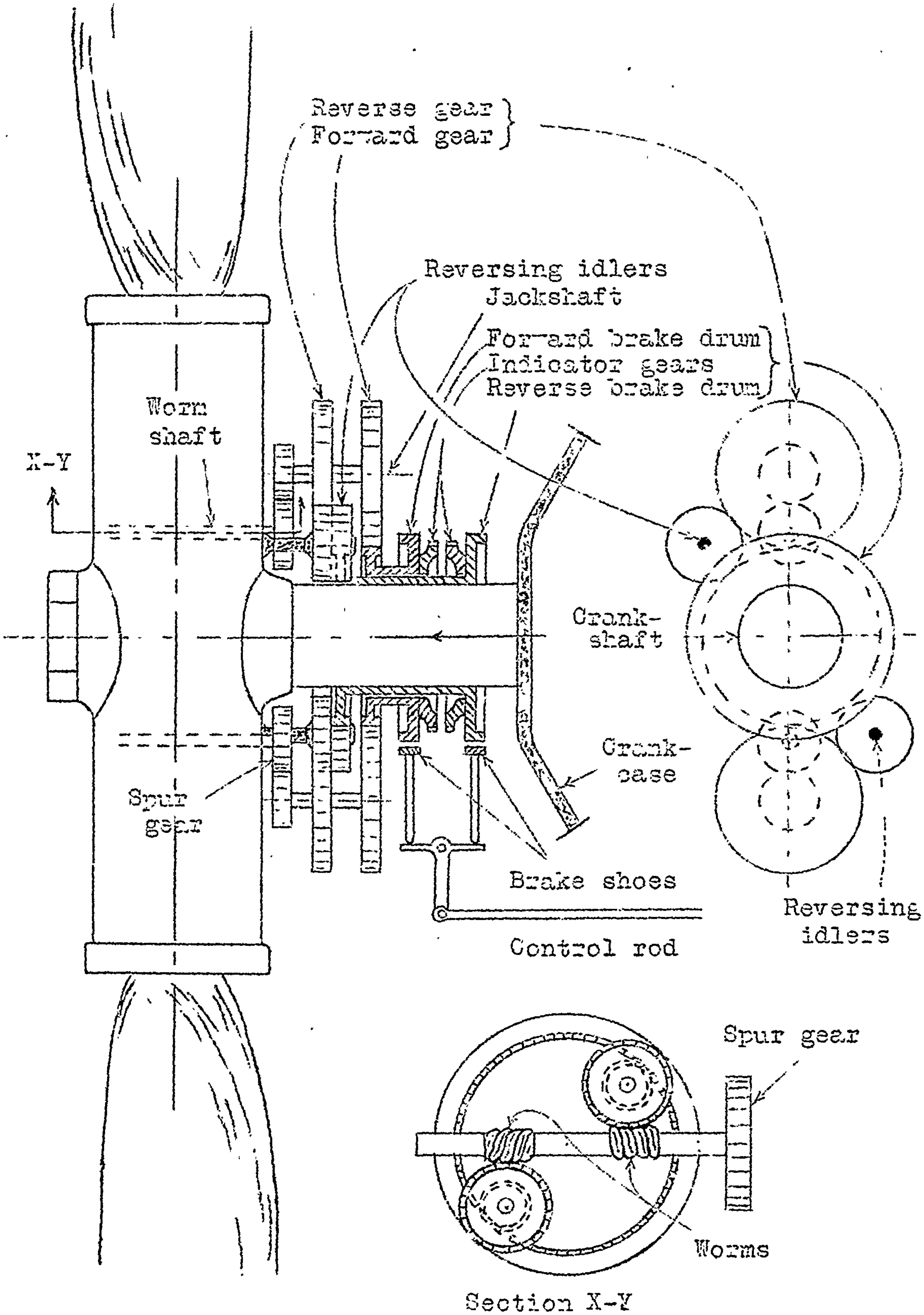

Fig. 3. Pitch changing gear train.